

THE ANT GENUS *SIMOPELTA*  
(HYMENOPTERA: FORMICIDAE)\*

BY WILLIAM H. GOTWALD, JR. AND WILLIAM L. BROWN, JR.

Department of Entomology, Cornell University  
Ithaca, New York

The taxonomic history of *Simopelta* (subfamily Ponerinae, tribe Ponerini) has been discussed in detail by W. M. Wheeler (1935) and by Borgmeier (1950). Borgmeier was the first to describe the queen of any species in the genus — that of *S. pergandei* — which he showed deserved to be called “dichthadiiform”, or belonging to a particular form of queen caste characterized by extreme reduction or loss of eyes, loss of wings, hypertrophy of petiole and gaster, and other characters. He explained its “great similarity to certain females of *Eciton*” by “convergence in its hypogaecic way of life”, a statement that is puzzling because, as Father Borgmeier well knows, *Eciton* is not really “hypogaecic” in its habits, at least as compared to the majority of ants that spend most of their time on or below the ground level.

At any rate, as we shall show in this paper, the convergence between the queens of at least one *Simopelta* species and certain army ants, so discerningly noted by Father Borgmeier, is only one aspect of the army-ant or legionary lifeform that two and perhaps all *Simopelta* species share with the “true” army ants of subfamily Dorylinae.

It is the purpose of this contribution to list and key the workers of the known species of *Simopelta*, to describe two new species of the genus, and to set forth on the behavior of one species some observations, however fragmentary, that will establish that it follows the army-ant way of life in important respects.

*Simopelta*

*Belonopelta* subgenus *Simopelta* Mann, 1922: 10. Type species: *Belonopelta* (*Simopelta*) *jeckylli*, by original designation.

*Simopelta*: W. M. Wheeler, 1935 (raised to generic rank). Borgmeier, 1950 (queen, young larva). G. C. and J. Wheeler, 1957 (young larva).

The generic diagnosis is basically that of Borgmeier modified and augmented according to the new material now available.

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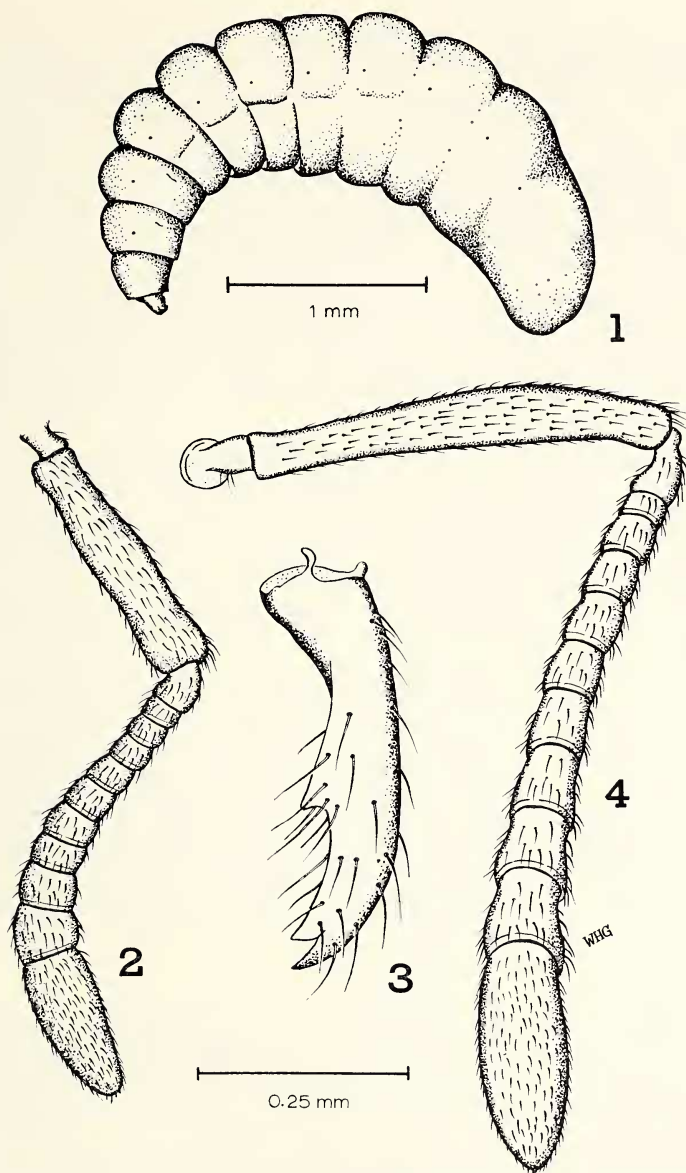
\*Manuscript received by the editor December 8, 1966

Worker: With the general characters of tribe Ponerini. Mandibles with the two apical teeth acute and forming a pair; followed basad by a short series of smaller teeth, by a single small tooth, or by a large diastema with or without one or more irregular indistinct denticles; a large acute or truncate tooth marks the basal angle. Antennae 12-segmented, second funicular segment small, no distinct club. Palpi segmented 2, 2 or 2, 3. Frontal lobes forming a raised platform, large and prominent, median part of clypeus falling sharply anteriad, sub-perpendicular to frontal region. Anteromedian clypeal margin projecting in a triangular point that in some species is produced as a slender, flattened spine or tooth. Eyes much reduced, condensed into a single, more or less convex facet, situated in front of the middle of the sides of the head, but not very close to the anterior corners. Promesonotal suture distinct and separating the segments; metanotal groove often indistinct, but more or less impressed. Petiole with steep anterior and posterior faces, apex weakly to strongly rounded, the node usually broader than long as seen from above; subpetiolar process thick and more or less triangular. Gaster with constriction behind postpetiolar segment weak to obsolescent. Sting well developed. Tibiae each with a single pectinate spur. Malpighian tubules 4 (checked only in *oculata*).

Queen (known only for 2 species: *pergandei* and *oculata*): dichthadiiform, i.e., with broad, subquadrate head: eyes reduced, flattened, but little larger than those of worker. Ocelli absent, or only the anterior ocellus present. Antennae shorter than in worker, both scape and funicular segments. Mandibles simple, acutely falcate. Thorax reduced, permanently wingless. Mesonotum with scutum and scutellum distinct and convex, or the latter reduced and fused with propodeum (?). Petiole transverse, broader than alitrunk, divided by a median sulcus. Gaster wide, with constriction after postpetiole poorly-marked or lacking; sting present and extrusible. Legs long; femora flattened; tibiae each with a single pectinate spur. Sculpture weaker than in corresponding worker, more shining.

Male unknown.

Larva: (only small larvae of *S. pergandei* and small and medium sizes of *S. oculata* are known; see Fig. 1.) Head small, longer than broad, hemicephalic; with simple, curved acute mandibles, their apices directed ventrad, so that they apparently work much as do the mouth-hooks of higher dipterous larvae. Antennae small, situated far back on cephalic dorsum. Pronotum elongate, tapering anteriorly, partly retractile, its neck-like structure most noticeable in the smaller larvae. The very smallest larvae seen (of *oculata*) are about 0.6 mm long by 0.3 mm wide, with head capsule about 0.11 mm wide. They



Figures 1-4, *Simopelta oculata* n.sp. Fig. 1, medium-sized (second instar?) larva, side view. Fig. 2, antenna of queen. Fig. 3, left mandible of worker, dorsal view. Fig. 4, antenna of worker. Figures 2-4 drawn to same scale.

range from this size to individuals up to 1.6 mm long and 0.9 or more mm wide, but the head capsule seems to remain at or near 0.11 mm wide throughout this series, which probably represents the first instar, or at most the first two instars. All but the smallest members of this series are very wide, due to the production of a wide, continuous longitudinal welt along each side that binds the second and all succeeding abdominal segments into one large flattened mass. Pronotum, mesonotum, metanotum and abdomen 1 are separated off by distinct constrictions in *oculata* of this instar.

Larger (second instar?) larvae of *oculata* (Fig. 1) measure about 3.2 to 3.6 mm in length straightened out, have the first 5 or 6 abdominal segments distinctly separated by constrictions, and are more nearly cylindrical in cross-section; the head capsule in this stage is still only about 0.12 mm wide.

According to the Wheelers, most abdominal segments of the small *pergandei* larva (L 1.6 mm straightened out) carry 8 minute tubercles each, 4 dorsal and 4 ventral, in transverse rows, but no tubercles of any kind could be found in the *oculata* larvae. All larvae of the genus so far found are completely hairless.

In *oculata*, the largest larvae numbered only about 10, as compared to some 690 of the smaller sizes. These largest larvae do not seem large enough to represent the final larval instar, and no *Simopelta* pupae were found. Of the smaller larvae, the vast majority were of the broad type, which possibly represents late first instar (or second instar). Whether or not we have the sequence correct, it can be seen that this particular brood had reached a peak at the older small larvae, with a few individuals having attained medium size and the succeeding instar, plus another small number of very young larvae tailing off at the other end of the size distribution. The impression of an *Eciton*-like brood cycle was further heightened by the apparently complete lack of eggs or pupae in the nest, and by the contracted state of the queen in life.

Borgmeier mentions examining 4 pupae of *S. pergandei* that were 2.8 mm long and not enclosed in a cocoon. Though cocoonless ponerines are no longer considered a great rarity, the strong possibility that *S. pergandei*, like *S. oculata*, raids ant nests for its livelihood leaves us to wonder whether the pupae may not have been those of a prey species.

Distribution. So far, *Simopelta* has been collected only in the forests of the warmer parts of the mainland Americas, from Guatemala in the north to Santa Catarina State, Brazil, in the south. *S. laticeps* was taken at about 2000 m in the Peruvian Andes, and two

species have been described from Ecuador. Probably we can expect to find more species in the Transandean area as well as elsewhere. The species have been collected only rarely so far.

**Habits.** The observations given after the description of *S. oculata* (below), the circumstance that the queens of two species are dichthadiiform, the peculiar *Eciton*-like reduction of the worker eye, the mandibular form, and certain details of the worker form and sculpture, all go to indicate that *Simopelta* is a mass-foraging, probably nomadic genus that has evolved far toward the army ant lifeform. *S. oculata*, at least, plunders the nests of other ants (*Pheidole* in the case observed). The observations for *S. oculata* and the collection figures given by Borgmeier (loc. cit.) suggest that nest populations may reach 1,000 or more workers, but probably do not go higher than 2,000. The *pergandei* series from Costa Rica studied by Borgmeier contained one fully adult queen and one callow queen, and thus may have been on the verge of dividing (swarming). The large mass of workers and brood in this collection suggests that, like the *oculata* sample, it was taken in a hollow twig or branch from which the colony could be collected at one stroke with little loss of inmates. The *oculata* colony had only one queen.

### The Species of *Simopelta*

#### *Simopelta curvata*

*Belonopelta curvata* Mayr, 1887, Verh. Zool.-bot. Ges. Wien, 37: 532, worker. Type locality: Santa Catarina State, Brazil.

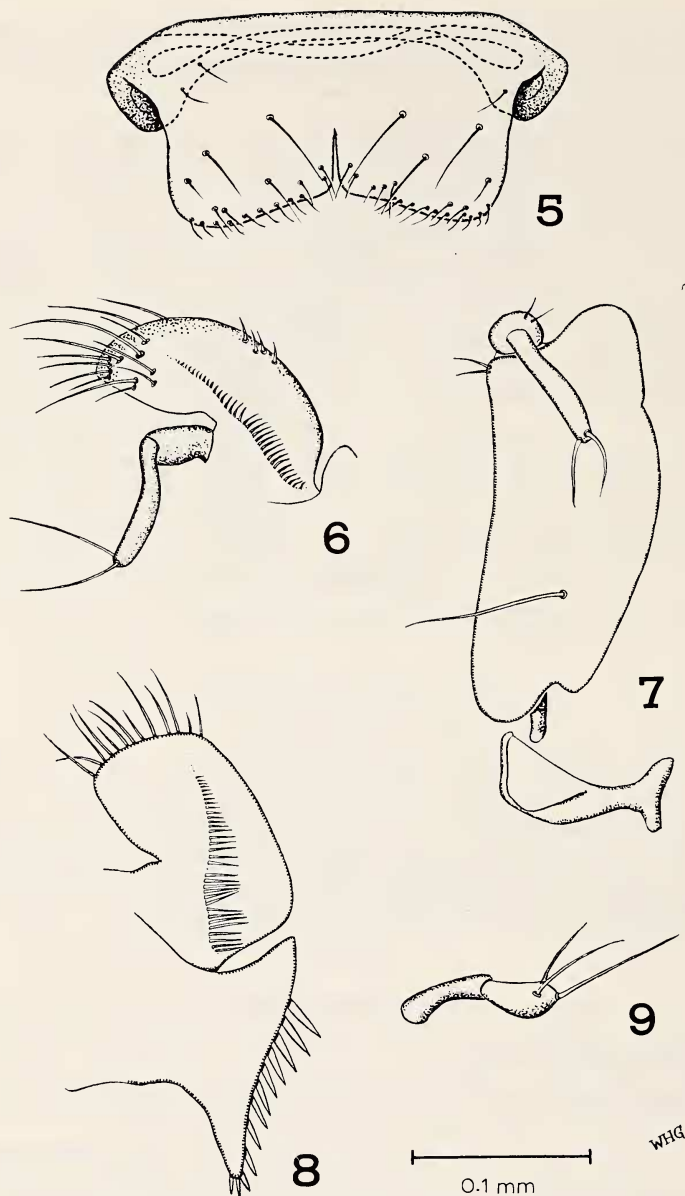
A light reddish-brown or yellowish-brown species with a well-developed clypeal spine and anteroposteriorly compressed petiolar node. Now known to be widespread in São Paulo State as well as Santa Catarina, and also in the interior of southern Brazil.

#### *Simopelta pergandei*

*Belonopelta pergandei* Forel, 1909, Deutsch. Ent. Zeitschr; p. 242, worker. Type locality: Guatemala.

*Simopelta pergandei*: Wheeler, 1935: 11, fig. 1, worker. Borgmeier, 1950: 372, fig. 1-12, worker, queen, young larva, pupa.

Very similar to *curvata* in general form, size, color and sculpture, but mandible with only 3 well-developed teeth. Funicular segments also more slender, and there are other small differences in the form of the node and in the sculpture. Known from Guatemala and from near San José in upland Costa Rica.



Figures 5-9, *Simopelta oculata* n.sp., mouthparts. Fig. 5, labrum, outside face. Figs. 6-8, different partial views of left maxilla. Fig. 9, labial palp. All drawn to same scale.



*Simopelta jeckylli*

*Belonopelta jeckylli* Mann, 1916, Bull. Mus. Comp. Zool. Harv., 60: 415, pl. 2, fig. 12, 13, worker. Type locality: Camp 39, Madeira-Mamore R.R., Mato Grosso, Brazil.

*Simopelta jeckylli*: Wheeler, 1935: 14, fig. 2, worker.

*S. jeckylli* is a relatively large, brightly-colored form (forebody piceous to bright ferruginous red, gaster contrasting red or yellow) with densely punctulate head and alitrunk. Clypeal spine present; only 3 well-developed mandibular teeth. No tooth on "mesosternum." Known only from the type collection, which consisted of workers from under forest litter that appeared to be "traveling in a definite direction," a description that suggests a foraging column.

*Simopelta williamsi*

*Simopelta williamsi* Wheeler, 1935: 14, fig. 3, worker. Type locality: Naranjapata, Ecuador, at about 600 m.

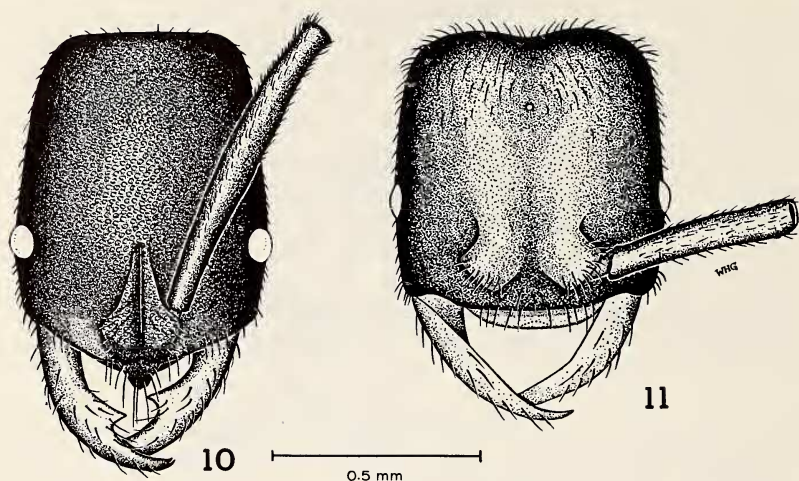
This species lacks a median clypeal spine, has very small eyes, and has the large basal tooth of the mandible truncate, with the truncate apex often even slightly concave. Piceous in color. Known only from the type collection.

***Simopelta oculata*** new species (Figures 1-14)

Holotype worker: TL 3.8, HL (without median lobe of clypeus, i.e., measured to anterior border of frontal lobes) 0.80; HW (without eyes) 0.58; WL (diagonal length of alitrunk as seen from side) 1.34; greatest diameter of eye 0.10; scape L (chord, without basal neck) 0.76 mm. Abbreviations as in Brown (1958: 254). Cephalic index (CI) 73.

Similar to worker of *S. williamsi*, but differing in the following ways:

1. Mandibles more slender, with the basal tooth simple and acute (basal tooth broad and truncate in *williamsi*).
2. Eyes notably larger than in *williamsi* or the workers of any other species in the genus so far known, but still composed of only a single convex (fusion) facet.
3. Antennal scapes longer; when laid straight back in full-face view, surpassing the occipital margin by distinctly more than their greatest apical thickness (by less in *williamsi*).
4. Alitrunk, especially the propodeum, both absolutely and rela-



Figures 10-11, *Simopelta oculata* n.sp., heads in dorsal view. Fig. 10, worker. Fig. 11, Queen. Drawn to same scale.

tively longer than in *williamsi*; pronotum with a feeble median impression on its dorsal face; propodeum with a feeble impression about midway on its dorsal face as seen in profile from the side.

5. Petiolar node longer, scarcely higher than long; as seen from above trapezoidal, slightly wider behind than long.

6. Transversely costulate elements of sculpture looser and less extensive than in *williamsi*, especially on head, where they are only weakly indicated on the extreme occiput, and then only in certain lights. Head otherwise densely reticulate-punctulate, opaque. Anterior face of pronotum with fine indistinct striation continuing onto lateral faces; disc and lateral faces of pronotum also with numerous shallow punctures; dorsum of alitrunk indistinctly roughened, almost smooth in places, weakly shining; anterior propodeum with some loose transverse rugulae extending up from sides; posterior sides of alitrunk with loose oblique to longitudinal rugulation, also a few oblique rugules on sides of petiolar node; petiolar summit loosely rugulose, weakly shining. Gaster smooth and shining, with very fine, superficial reticulation on dorsum, as in *williamsi*.

7. Color dark brown, head brownish-black; mandibles, antennae, legs, sides of pronotum, lower petiolar node, and gaster prevailingly castaneous.



Type nest series taken a short distance (about 1/2 km) beyond (NW of) the bridge over the Rio Toro Amarillo, near Guapiles, Limon Province, Costa Rica (N. Scott and W. L. Brown, Jr. leg.).

Holotype worker deposited in Museum of Comparative Zoology, Harvard University, together with queen from type nest.

Paratype series: 42 workers from type nest series taken "randomly" from a larger series in alcohol; 10 measured, including the apparent largest and smallest specimens: TL 3.6-3.9, HL 0.79-0.81, HW 0.57-0.60, ML 0.21-0.24, WL 1.31-1.40 mm. CI 72-74. Non-metric variation: Color varies from predominantly deep castaneous to piceous, with the head nearly black. Sculpture on sides of alitrunk and petiole varies somewhat in distinctness and direction.

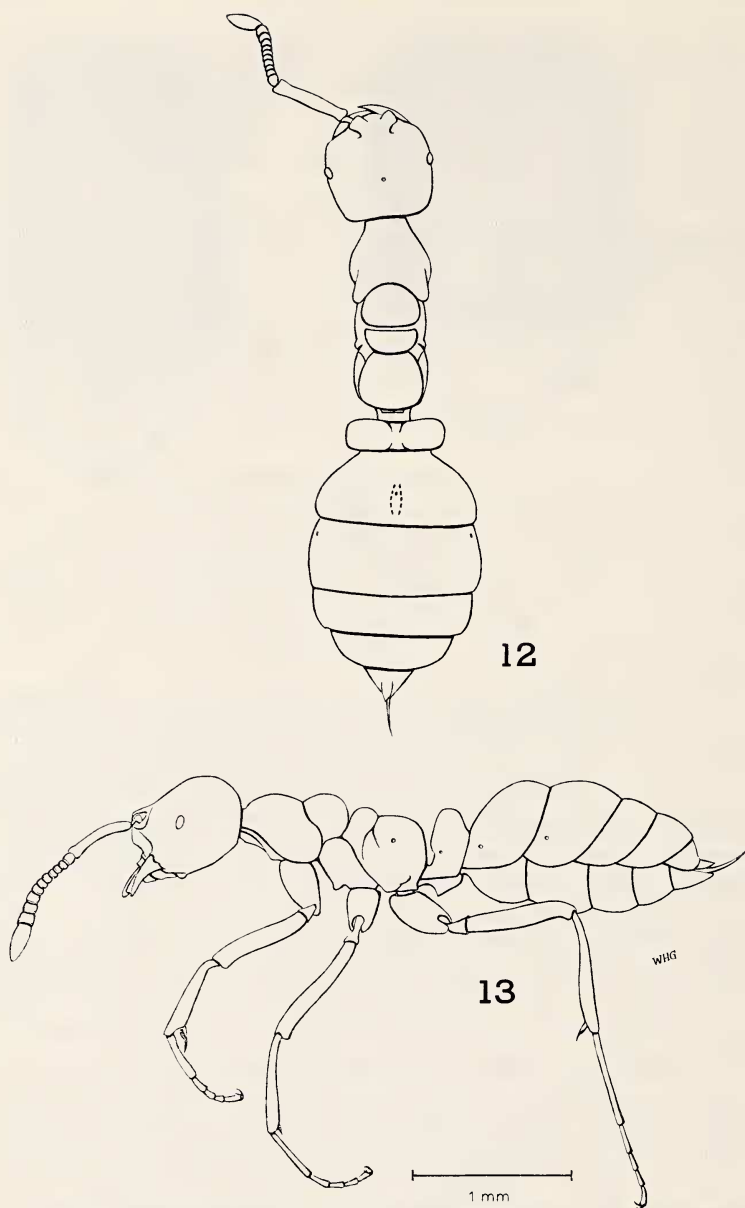
Upon dissection, 4 live workers each proved to have 4 Malpighian tubules.

Paratypes deposited in Museum of Comparative Zoology, Harvard University; Cornell University Collection; Departamento de Zoologia, São Paulo; California Academy of Sciences, and elsewhere.

Queen (a single dichthadiiform female from type nest, gaster contracted): TL 3.6, HL (from anterior clypeal border) 0.68, HW (without eyes) 0.67, WL 1.18, greatest diameter of eye 0.11, scape L 0.46 mm. CI 99.

Shape of head and body shown in Figs. 2, 11-13. Outstanding differences from the worker may be seen in the shape of head, antennae and mandibles, thoracic sclerites, deeply bilobate petiole, and broad gaster with median sulcus on the first tergum. Eyes a bit more elongate and showing more traces of facetting, set obliquely on sides of head. Funicular antennomeres broader than long, except first and last. A single small median ocellus, in front of which is a broad, transverse shallow sulcus. Sting well developed and extrusible. Femora slightly flattened, weakly incrassate, the broad faces feebly sulcate. First gastric tergum with a broad, shallow, longitudinal median sulcus, in the middle of which is an indistinct pore. Lower edge of metapleural gland bulla cultrate, conspicuously ivory in color; meatal guard hairs 5-6 in number, long and fine.

Sculpture mainly smooth to nearly smooth, shining; head and anterior dorsum of alitrunk shallowly roughened and with indistinct punctures; finer piligerous punctures scattered over propodeum, petiole and gaster. Appendages finely, densely and shallowly punctulate, weakly shining. Entire body, including mandibles and appendages, but excluding large parts of coxae and sides of alitrunk, with abundant fine, yellowish-white, decumbent to suberect pilosity



Figures 12-13, *Simopelta oculata* n.sp., queen, habitus drawings, pilosity omitted. Fig. 12, dorsal view. Fig. 13, lateral view. Drawn to same scale as Figs. 14-15.

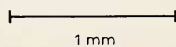
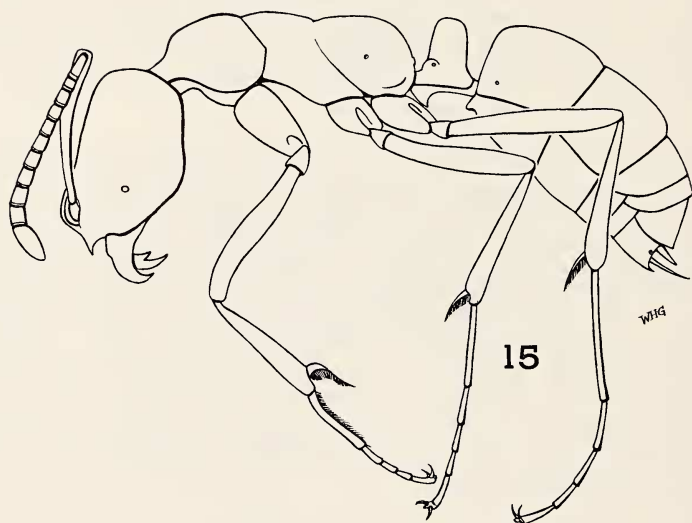
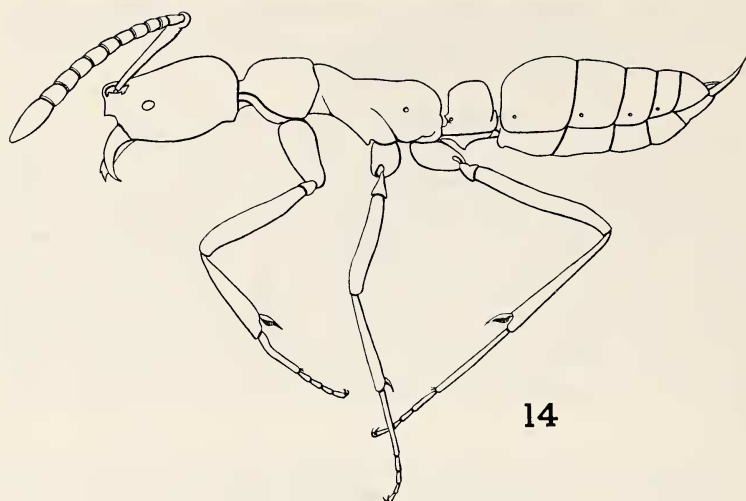
of uneven but moderate length, most abundant and longest on gaster. Color piceous, pronotum a little lighter and more reddish; mandibles and appendages lighter, yellowish-brown.

The colony of *S. oculata* was found by chance at about 9 A.M. on the morning of 2 March, 1966. Mr. Norman Scott, in charge of the Course in Fundamentals of Tropical Biology, Organization for Tropical Studies, and Brown were wading up a brook in second growth rain forest. We were looking for foraging columns of an *Eciton lucanoides* colony that had moved in this direction from a log bivouac dissected by us the day before. Mr. Scott directed Brown's attention to files of slender, dark-colored ants marching over vines and shrub stems along the margin of the brook. On seeing the ants, he immediately concluded that they must be some *Simopelta* species.

The route of the ants ranged from about 30 cm to 150 cm above ground level over vine and stem, and lay entirely in deep shade. They moved in dense single file, almost all in one direction, which proved to be nestward. Following the file for perhaps 6 meters stretched-out distance, we shortly discovered the nest, which occupied a straight, completely hollow dead twig about 1.5 cm in diameter and 33 cm long, suspended vertically by a dead vine about 1.5 m above the ground in dense second-growth forest.

The single incoming column was burdened with the larvae, pupae, and pharate adult workers and soldiers of a medium-sized species of *Pheidole*, clearly the dominant ant genus of this area. Partly eaten prey specimens were later found among the nest contents. The twig containing the nest was removed to a plastic bag and kept for later laboratory opening. The column was not traced back toward its origin, but we estimated that it contained at least several hundred *Simopelta* ants in the files we saw. The nest twig contained 361 workers by count when it was opened, and it hardly seemed spacious enough to contain more than 2,000 workers plus a queen, the prey, and the brood found, about 700 in number, which consisted entirely of small and medium larvae.

When the queen was found upon opening the nest twig, she ran rapidly, always followed by at least one worker whose head literally rested upon her gastric dorsum as it followed immediately in a tight tandem. The queen with her attendant resembled some multi-legged animal, so close and persistent was the association. Although the exact position of the worker's head could not be seen as the pair ran



Figures 14-15, *Simopelta* n.spp., workers, habitus drawings, pilosity omitted.  
Fig. 14, *S. oculata*, lateral view. Fig. 15, *S. laticeps*, lateral view.

along, it seemed likely that the worker's mandibles or under-mouth-parts rested in the median sulcus of the queen's postpetiolar tergum.

The workers ran rapidly, holding their antennae in much the same way as *Dorylinae* do, and quickly formed files along obvious odor trails newly laid on a blank paper surface. Altogether, the impression of the colony behavior received was that of an army ant. The slender bodies of the ants reminded one of mass-foraging *Leptogenys* species, such as those of the *diminuta* complex of the Indo-Australian area.

*S. oculata* proved able to sting, at least through the thin skin on the back of human fingers. The sting felt about like a mosquito bite, and lasted similarly.

### *Simopelta manni*

*Simopelta manni* Wheeler, 1935: 17, fig. 4, worker. Type locality: Mera, Ecuador.

This species has acutely 3-toothed mandibles and no clypeal spine. Eyes very convex, but smaller than those of *oculata*. "Mesosternal" tooth present. Pronotum and much of head smooth and shining. Petiolar node a little broader than long. Color black. Known only from type material.

### *Simopelta bicolor*

*Simopelta bicolor* Borgmeier, 1950: 377, fig. 13-20, worker. Type locality: Santa Teresa, Espirito Santo, Brazil.

Mandibles with 5-6 irregular teeth basad of the apical pair. No clypeal spine or "mesosternal" tooth. Petiolar node much broader than long. Head and alitrunk densely punctulate. Bright ferruginous red; petiole and gaster yellow. Known only from type material.

### *Simopelta laticeps* new species (Figures 15, 16)

Holotype worker: TL 4.9, HL 1.03, HW 0.93, WL 1.65, greatest diameter of eye 0.05, scape L 0.91 mm. CI 90.

Immediately separable from the other known species of the genus by means of its wide, convex-sided head with notably concave occipital margin. The median clypeal lobe bears a slender subspatulate tooth, and the mandibular armament consists of 4 strong, acute teeth.

General form of body and appendages shown well in Figs. 15 and 16. Petiolar node broader than long. Head finely and densely striato-punctulate in a longitudinal direction; dorsum of pronotum and mesonotum with similar sculpture, arched concentrically; sides of alitrunk mostly longitudinally striate; dorsum of propodeum and



petiolar node shining, with spaced small punctures, mesally impunctate; declivity of propodeum and front, rear and sides of node shining, with delicate horizontal reticulo-striation. Mandibles very finely striolate, sericeous, with a few coarse elongate punctures. Legs and antennae finely and densely punctulate, the legs more shining than the antennae. Gaster smooth and shining with numerous minute, spaced punctulae.

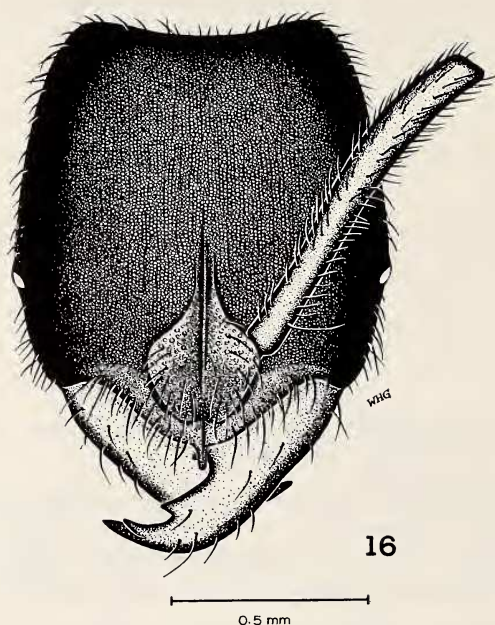


Figure 16, *Simopelta laticeps* n.sp., head in dorsal view. Drawn to same scale as Figs. 10-11.

Body including appendages, covered with a short, fine, mostly decumbent or curved-subappressed pilosity, sparse on mandibles and sides of alitrunk, absent from anterior face of first gastric tergum. Longer fine hairs, mostly erect, are found mainly on the anterior parts of the head and near the antennal scape bases, on the underside of the head, scattered over the dorsal surface of the alitrunk, on the anterior coxae and beneath the prothorax, at the apex and on the underside of the gaster.

Color deep piceous, nearly black; mandibles and other appendages lighter, more reddish (castaneous).

Holotype and a single paratype worker on a separate pin received from Dr. E. S. Ross of the California Academy of Sciences, bearing the following label data: "PERU: 28 mi. E. Olmos, Lambayeque. 2000 m. 1-19-1955. E. I. Schlinger & E. S. Ross collectors." It seems possible that these two workers were part of a larger series, the bulk of which may still be stored in alcohol at the Academy of Sciences. My query about this collection reached Dr. Ross while he was in the midst of preparations for a long trip, when he had no time to search through the extensive collections of ants in alcohol. He did, however, furnish the additional information about the type locality in a letter: "The locality 28 mi. E. of Olmos is a curious cloud forest zone on the *west* slope of a low Andean pass. The east slope is desert!"

Paratype worker: TL 5.5, HL 1.08, HW 0.98, WL 2.00, greatest diameter of eye 0.06, scape L 0.93 mm. CI 91. Very similar to holotype in all details checked.

Holotype in California Academy of Sciences, paratype in Museum of Comparative Zoology, Harvard University.

#### Key to *Simopelta* workers

1. Head  $> 0.80$  mm wide; occipital margin distinctly concave in the middle as seen in dorsal full-face view (Fig. 16); brownish black (E. Peru) ..... *laticeps*  
 Head  $< 0.80$  mm. wide; occipital margin approximately straight (feebly convex to extremely feebly concave in dorsal full-face view) (Fig. 10) ..... 2.
2. Pronotum smooth and strongly shining, as are a large part of the anterior dorsum of the head and various other parts of the alitrunk; black (Ecuador) ..... *manni*  
 Head and alitrunk, including pronotum, sculptured and more or less opaque ..... 3.
3. Mandibles with a large apical tooth, followed basad by 6 or more irregular smaller teeth in series; bright ferruginous red, appendages, petiole and gaster yellow (Brazil: Espirito Santo) ..... *bicolor*  
 Mandibles with two large teeth at apex, followed basad by a large diastema, (containing at most 1 to 3 spaced denticles) or one moderate-sized tooth, and finally a large basal tooth ..... 4.

4. Eyes large and conspicuous, greatest diameter = greatest width of antennomere 4 (Figs. 10, 14); dark brown (Costa Rica) ..... *oculata*  
 Eyes smaller, greatest diameter distinctly < greatest width of antennomere 4 ..... 5.
5. Occiput, front of pronotum, mesonotum and propodeum more or less distinctly transversely striate or rugulose; median clypeal lobe without a slender tooth or process (Fig. 10); blackish brown (Ecuador) ..... *williamsi*  
 Head and alitrunk as seen from above uniformly and densely punctulate; median clypeal lobe with a narrow tooth or process, variable in form (Fig. 16); color lighter, brown or reddish, or bicolored ..... 6.
6. Mandible 4-toothed; third tooth (counting apical tooth as first) at least half as large as basal (fourth) tooth, well-developed and acute (SE Brazil) ..... *curvata*  
 Mandible with only 3 well-developed teeth; broad diastema between second tooth and basal tooth unarmed or with at most a few low, irregular denticles or crenulations ..... 7.
7. Larger species (head width usually > 0.66 mm); punctation of head, alitrunk and node coarse, separate punctures of head not much smaller than eye; color ferruginous red to piceous, with contrasting yellow or red gaster and appendages (Brazil: NW Mato Grosso) ..... *jeckylli*  
 Smaller species (head width usually < 0.66 mm); punctation fine and shallow, separate punctures of head not more than about 1/3 the size of the eye; color yellowish-brown to medium brown (Central America) ..... *pergandei*

## ACKNOWLEDGEMENTS

We owe thanks to Father W. W. Kempf, OFM, for his sending of the sample of *S. curvata*, and to the National Science Foundation for support under grants (GB-2175, GB-5574X), W. L. Brown, Jr., principal investigator.

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#### THE ANT *CATAGLYPHIS BIRMANA* A SYNONYM —

The specimen described as *Cataglyphis birmana* by Collingwood in 1962 (Ent. Tidskr., 83: 227, figs. 8, 9; type locality Malvedaung, Tenasserim, Burma, 300 m) is a worker minor of *Camponotus singularis* (= *Formica singularis* F. Smith, 1868, Cat. Hym. Brit. Mus., 6: 27; type locality "Java.") *New synonymy*. The type of *C. birmana* was loaned by Dr. Eric Kjellander through the courtesy of Mr. C. A. Collingwood, and has been returned to the Naturhistoriska Riksmuseum, Stockholm. — W. L. Brown, Jr., Department of Entomology, Cornell University.